MAR08-2007-000719

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Universal Quantum Gates for Two- and Three-Spin Qubits in Coupled Quantum Dots

GUIDO BURKARD, RWTH Aachen University, Germany

The ability to control the exchange coupling between coupled quantum dots allows for quantum gate operations on quantum dot spin qubits. Supplemented with single-spin rotations, the exchange coupling is universal for quantum computation on qubits that are formed by the spin 1/2 of single electrons. If qubits are formed by two spins, the requirement for single-spin rotations is reduced to the presence of a fixed inhomogeneous magnetic field, while for three spins, the exchange coupling is universal on its own. In this talk, we discuss the implementation of universal gate operations for two- and three-spin qubits in coupled quantum dots. In the case of the two-spin singlet-triplet qubit on a double quantum dot, we propose a set of universal gates that can be generated by controlling the electrostatic potential between the two dots without time-dependent control of the tunnel coupling between the dots [1]. This simplification should facilitate the implementation of quantum gates in the systems that are presently studied experimentally. We present explicit gate sequences for single-qubit rotations about two orthogonal axes, and a CNOT gate sequence, completing the universal gate set. Finally, the trade-off between leakage errors and simple operations will be briefly discussed.

[1] R. Hanson and G. Burkard, Phys. Rev. Lett. **98**, 050502 (2007).